THE FAMILY OZOBRANCHIDAE REDEFINED, AND A NOVEL OZOBRANCHIFORM LEECH FROM MURRAY RIVER TURTLES (CLASS HIRUDINOIDEA; ORDER RHYNCHOBDELLIFORMES)

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Synopsis

A new genus is provided for a leech from *Emydura macquari* at Lake Boga, Victoria, novel in possessing digitiform gills, etc. This is the first freshwater clitellate rhynchobdellid known in Australia. The external features of *Ozobranchus branchiatus* and *O. margoi* are described from specimens taken from marine turtles at Heron Island, which gives the first record of *O. margoi* in the southern hemisphere, and is the fifth time the species has been taken. The redefined Family Ozobranchidae excludes the genus *Branchellion*.

Specimens of a small ozobranchiform leech sent me by Mr. John Goode and Mr. Peter Meyer of Victoria, possess 8 pairs of gills which are tapering cylindrical, digitiform, terminating bluntly without division into the tufts of finely filamentous gills typical of the ozobranch, and so resemble the gills on the late embryo and newly hatched ozobranch; but these are adult specimens. These leeches were taken from *Emydura macquari* at Lake Boga, 10 miles from Swan Hill, Victoria, on the Murray River system. Egg-capsules of *Bdellasimilis barwicki* Richardson 1968 were taken with the leeches, but no leech cocoons were seen. According to Sanjeeva Raj (1954), the only other freshwater species of ozobranch is *Ozobranchus papillatus* Kaburaki 1921, in North India.

Previously (Richardson, 1968) only the marine *Ozobranchus branchiatus* was known from Australia, being figured by MacDonald (1877) but not identified by him or described in detail, and referred to without detail by Goddard. Through Dr. John Pearson I received two specimens of *Ozobranchus* taken from *Chelonia mydas* at Heron Island by Dr. H. R. Bustard early in 1968. One specimen is *O. branchiatus,* the other the rare *O. margoi* which has been taken only four times previously, originally in the Mediterranean, twice in Japanese waters, and once in the Bay of Bengal. This is the first record of *O. margoi* on *Chelonia mydas,* and the first time in which two species of ozobranch have been taken from this turtle. The external details of these two specimens are described; but the condition of both was unsuitable for close internal study by dissection, which is most unfortunate for there are conflicts in the accounts of the internal anatomy of *O. branchiatus* and the one account of the internal anatomy of *O. margoi* is questionable on some points.

The Lake Boga leech is the first clitellate rhynchobdellid found in Australian freshwaters. It is clearly a new genus. The external and internal morphology conforms to that of the ozobranch leeches so far as known and as seen in the dissection of the two marine species, and provides a morphological basis for the establishment of a separate family, so removing the ozobranchids from the Family Piscicolidae, a small but initial intrusion into the systematic complexities of the clitellate rhynchobdellids.

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The rhynchobdellid leeches possess a small circular pore-like "mouth" on the anterior sucker and an eversible cylindrical proboscis with a restricted, very narrow lumen so that all are liquid feeders. They have long been and are currently accepted as divided into two families: the Family Glossiphonidae Vaillant 1890, non-clitellate leeches, the body without division into a distinct anterior sucker, a neck, and abdomen, freshwater, predatory, and sanguivorous or otherwise parasitic; and the Family Piscicolidae Johnston 1865, clitellate, the body with a narrow-based anterior sucker, a neck distinct from the sucker, and in most the neck also sharply defined from the abdomen, temporary to permanent ectoparasites of aquatic animals (fish, mollusca, arthropods, etc.), marine and freshwater, sanguivorous (and possibly some mucus feeders).

With over 45 genera (Soos, 1965), the piscicolids are the most richly diversified group in the Hirudinea as currently understood. Only two of these genera possess external gills: the genus *Branchellion* Savigny 1822, marine, ectoparasitic on fish (chiefly elasmobranchs), with 3 pairs of gills on each branchiate somite, etc.; and the genus *Ozobranchus* Quatrefages 1852, marine and freshwater, ectoparasitic—typically on Chelonia, with only one pair of gills per branchiate somite, etc. Because of the presence of gills in both, the two genera have been nearly always, and are currently associated systematically. Since *Branchellion* is typically piscicolid, the association of the two has resulted in *Ozobranchus* being retained in the Piscicolidae.

Vaillant (1890) summarizes earlier writers in recognizing a Family Ichthyobdellidae (now Piscicolidae) divided into a sub-family Branchellionae (*Ozobranchus, Branchellion, Calliobdella, Hemibdella*) and a sub-family Pontobdellinae. Leigh-Sharpe (1916) provided a more extended Branchiobdellinae; Pinto (1921), a Family Ozobranchidae, and later a sub-order Ozobranchida; Caballero (1960), a sub-family Branchelliinae; etc.—all such containing both genera of gilled "piscicolids". Poirier and Rochebrune (1884) provided a Family Lophobdellidae for a new ozobranchid leech; but neither this nor the Family Chelyobdellidae of Apathy (1890) for another ozobranch, nor any of the other proposals have been sustained in the recent reviews of the Piscicolidae by Knight-Jones (1962) and by Soos (1965), nor earlier (Autrum, 1936), etc., excepting that Silva (1960) retains a Tribe Branchiobdellinae containing the gilled "piscicolids" and some other genera, those having external pulsatile vesicles. In this group, the ozobranchs alone lack such vesicles, and the implied relationship cannot be sustained.

From my earlier experience of *Branchellion* and other piscicolids, the detailed study of the new ozobranchid emphasized the strong contrasts between the branchellionid and ozobranchid leeches, and the homogeneity of the latter both externally and internally so far as is known. In the genus *Branchellion* (see Meyer, 1941; Richardson, 1949; Moore, 1952; etc.) the the proboscis ends in segment viii or ix and glands enter at this point; a thin-walled tubular oesophagus continues to xiv, followed by a crop with 4 pairs of lateral caeca and a perforated median postcaecum; the intestine has several pairs (4) of lateral compartments. All this and other features are piscicolid and differ from the ozobranch.

Disregarding the presence of gills, then in the absence of lateral keeling, tubercles or conspicuous papillae, with less than four pairs of eyes, an annulation of a low order, and fully separate postcaeca, the ozobranch leeches would fall in Soos's analysis (1965) of the piscicolids into association with *Arctobdella* and *Sanguinothus*, two marine genera having only 18 (19—Knight-Jones, pers. comm.) independent ganglia on the nerve cord, but three are fused into an "anal ganglion of Apathy" and appear as a single element. Both

have the typical short piscicolid proboscis, lateral pouches on the intestine, etc. and a relationship of the three cannot be sustained. In my own analysis (1959), the ozobranchs were associated with *Oceanobdella* (=*Abranchus*), *Ganymebdella,* and *Ottionobdella,* all having separate postcaeca (to these would be added *Arctobdella* and *Sanguinothus* described in 1961) but this group of five genera is unacceptable on the above basis. In the analysis by Knight-Jones (1962), the ozobranchs would fall into a group containing *Arctobdella, Ottoniobdella, Cryobdella,* etc. In contrast, *Branchellion* would become grouped with (Richardson) *Cystobranchus, Calliobdella;* with (Soos; Knight-Jones) *Trachelobdella* and *Calliobdella;* and shows conformity with the abranchiate *Calliobdella* in many respects.

There is nothing here to suggest that *Branchellion* is other than a piscicolid; that the branchellionids and ozobranchs have resemblance other than in the possession of gills; or that the ozobranchs have fundamental relationship with any group of genera in the Piscicolidae. Accordingly I provide below a separate family for the ozobranchid leeches. Under the Rules, there is no option other than to revive but redefine the Family Ozobranchidae Pinto 1921.

Family Ozobranchidae Pinto 1921 (Redefined)

Clitellate rhynchobdellid leeches; no external pulsatile vesicles; mouth-pore excentric; short proboscis followed by a longer pharynx terminating at xii/xiii; anterior intestine partially or completely a crop but lacking morphological compartments and with an anterior pair and posterior pair of caeca; posterior intestine with an anterior region carrying four pairs of dorsally directed tubular diverticula, the posterior region acaecate; testes compact, paired; male paired ducts terminate in a median muscular organ; anterior ganglionic mass includes 8 somital ganglia.

Marine and freshwater. Ectoparasitic on aquatic Chelonia and Crocodilia, known also from dolphins and the pouch of pelicans.

Type genus: *Ozobranchus* Quatrefages 1852.

The above definition being based on *Ozobranchus* might include the presence of gills, and the division of the abdomen into a branchial region carrying only one pair of gills to each somite, and a postbranchial region. With the example of *Branchellion* in the otherwise abranchiate Piscicolidae, it is reasonable to anticipate that the Ozobranchidae might attract abranchiate genera when a more complete knowledge of the clitellate rhynchobdellids has been gained. Such genera should conform to the nature of the ozobranch alimentary canal and reproductive systems. In the typical piscicolid male system, the paired male ducts terminate as well-developed separate dilated atrial cornua which enter independently into a median atrium (usually referred to as a "bursa"), a morphological organization associated with the production of a cylindrical sharp-ended spermatophore showing an essential double nature. There is no knowledge yet of the ozobranch spermatophore, but the terminal organs of the male system do not conform to the production of the typical piscicolid spermatophore. There is some morphological similarity to the terminal male organs in *Calliobdella* and *Trachelobdella* (e.g. *T. leptocephali* Ingram 1957) in the seminal vesicles each connecting by a short duct into a median muscular organ opening into the bursa. *C. lophii* (=*T. punctata*) has a short sac-shaped single-chambered spermatophore; but otherwise both genera are typically piscicolid, as is shown in the alimentary system. Conductive tissue is lacking in *Trachelobdella* and *Ozobranchus* (Selensky, 1915). All this appears to express parallelism but not relationship, a circumstance such as in the hirudinids (Richardson, 1969).

Genus Ozobranchus Quatrefages 1852

Ozobranchidae; ozobranchiform; anterior abdominal somites carrying each one pair of gills divided distally into many filaments; separate male and female genital pores; crop extends the length of the anterior intestine; anus at xxvi/xxvii.

Marine and freshwater. Ectoparasitic on *Chelonia,* recorded also from dolphins and the pouch of pelicans.

Type species: *Hirudo branchiata* Menzies 1791. Tropical Pacific.

Of the six species currently accepted in *Ozobranchus* (Soos, 1965), *O. branchiatus, O. jantseanus* (as also *"Lophobdella" quatrefagesi*) have separate genital pores. *O. shipleyi, O. margoi,* and *O. polybranchus* have a common genital pore, as in the new leech from Lake Boga. I have shown (Richardson, 1969) that generic relationships in the hirudinid leeches can be determined only from the internal morphology. This has been the approach with the rhynchobdellids for the past 80 years. The presence of one, as against two genital pores indicates probable differences in the terminal organs of the reproductive system such as may require a division of the above leeches into two groups, probably generic in status. The genus *Lophobdella* Poirier and Rochebrune 1884 was listed by Harding (1927) as a possible synonym of *Ozobranchus,* accepted as such by Autrum (1936) who figures *O. quatrefagesi* (1932) as also Harant and Grasse (1959). The species is not referred to by Sanjeeva Raj (1954) or Soos (1965) although both list crocodiles as hosts for *Ozobranchus,* this being known only for *quatrefagesi.* Both *branchiatus* and *quatrefagesi* have seven pairs of gills and two genital apertures; but the latter are described by Poirier and Rochebrune as on annuli 7 and 8 from which it is clear that *quatrefagesi* is a species uniannulate on the venter of the neck and so distinct from *branchiatus.*

Ozobranchus branchiatus (Menzies 1791)

(Fig. 1 A, B, & D; Fig. 3 J)

Although a classical text-book animal for over a hundred years, records of this species are few. Sanjeeva Raj and Penner have only recently (1962) given the first detailed description of the externals. Taken originally in the Pacific, it is now known from Japanese waters, off the east and west coasts of India, off Sarawak, off Florida, and in Australian waters. The only known host is the green turtle, *Chelonia mydas,* with infestations ranging up to many hundreds on a single turtle. There is no previous record of it associated with a second species. The following description is based on a single specimen taken early in 1968 from near the vent of *C. mydas* at Heron Island by Dr. H. R. Bustard.

It is compactly club-shaped with strongly marked intersomital and interannular furrows; transversely and longitudinally convex above; flattened below; the anterior sucker wider than and set off from the neck which is briefly covered posteriorly by a prepuce. The abdomen is divided into the anterior branchial region carrying seven pairs of tufted filamentous lateral gills, and a shorter postbranchial region terminating to provide a wide basis for the heavily muscular sucker. The lateral margins diverge from the base of the anterior sucker to a maximum width at about the fourth pair of gills, are then subparallel, converging only slightly to curve obtusely from xxiii posteriorly. Nephropores are not detectable. Somital sense organs are low in profile, central in a_1 a_2 and obvious on the dorsum of the abdominal somites, but not on the venter.

The total length is 10·5 mm. The ovoidal anterior sucker is 1·5 mm. wide by 1·7 mm. high; the neck, 1·2 mm. wide by 1·0 mm. deep anteriorly, increasing

to nearly 2·0 mm. in both diameters posteriorly where it is subcircular in section. The greatest width of the abdomen is 3·6 mm. at the fourth pair of gills where the depth is 3·0 mm., increasing to a maximum depth at about xxii behind which the depth diminishes and the dorsal profile is rounded to the base of the sucker. The base is about 2·8 mm. wide, more than half the width of the sucker which is 3·0 mm. wide and 2·75 mm. in length.

The colour (preserved) is white without pigment or pattern.

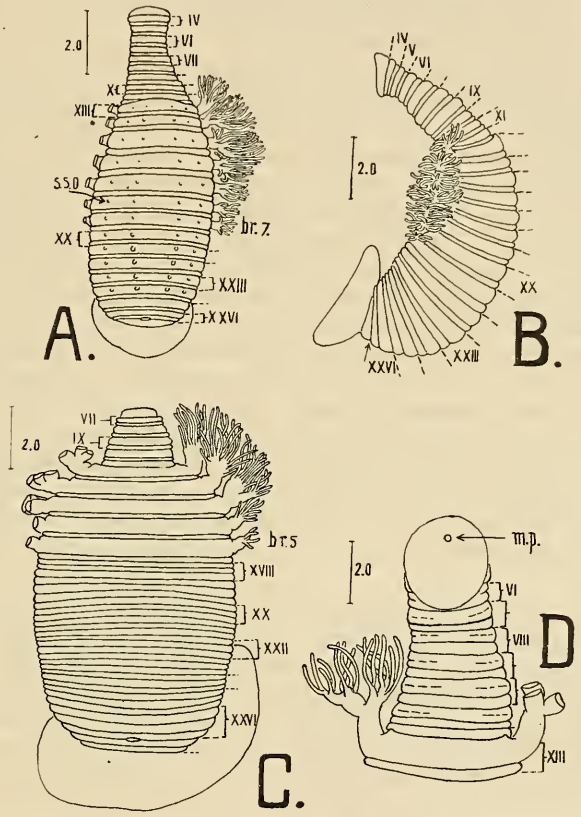


Fig. 1. A. *Ozobranchus branchiatus*, dorsal view, and B. lateral view. C. *Ozobranchus margoi*, dorsal view. D. *O. branchiatus*, ventral view of anterior sucker and neck. See key to lettering on figures, p. 80.

The face of the anterior sucker is oblique; the mouth-pore excentric, about half-way between the centre and the dorsal margin which is formed by the velum and continuous with the lateral and ventral margins, the margins being all anterior to the well-defined anterior limit of iv, so that iv does not contribute to the margin. Somite iv is 2-annulate, with $a_1\ a_2 > a_3$ and complete on all aspects. There are no indications of eyes on iv. Somite v is narrower than iv, is 2-annulate on all aspects with $a_1\ a_2 > a_3$ above but more nearly subequal below; vi with $a_1\ a_2 > a_3$ above and below, and with traces of a furrow a_1/a_2 at the margins; vii to xi, 2-annulate above and below with $a_1\ a_2 > a_3$ on all aspects, and with weak indications of a_1/a_2 on the ventral intermediate and submarginal areas; xii, 2-annulate above and below, with $a_1\ a_2 = a_3$; the male genital pore is situated in the furrow $a_1\ a_2/a_3$, and the female pore in the middle of xii a_3.

The abdominal somites xiii to xxvi, are regularly 2–annulate, with $a_1\ a_2 > a_3$ above and below, a_1a_2 longer above than below and markedly more so in the postbranchial somites. The anus is at xxvi/xxvii. Somite xxvii is uniannulate in this specimen, not 2–annulate as in Sanjeeva Raj and Penner (1962), and xxvii does not continue onto the venter.

The first gill is of the general dimension of the second, but with fewer filaments; the second and third are nearly equal in size with about 15 filaments in the tuft; the fourth, smaller; the fifth, smaller again and with some 8 filaments; the sixth smaller; and the seventh the smallest in the series, markedly smaller than the first, and with some 8 filaments.

The specimen is not well-preserved internally. The internal anatomy so far as seen in hand dissection is ozobranchid. The anterior ganglionic mass is just posterior to vi/vii, with two independent ganglia between it and the terminal mass of the male reproductive system, the nerve cord then arching high over the mass so that the third ganglion is anterodorsal, and the fourth dorsal; closely similar to *Bogabdella*. The proboscis terminates at vi/vii, followed by a strongly muscular pharynx extending to xii/xiii, with two pairs of elongate glands entering at a point about two-thirds along the length, each gland a cord of large cells. The pharynx arches above the terminal mass of the male system to join to a tubular crop, filled with blood, swollen, and as seen from above apparently divided into five sub-equal compartments weakly marked off from each other by shallow open lateral grooves; but as these grooves do not continue onto the dorsal and ventral aspects of the crop, and as the postcaeca originate from the middle area of the side-wall of the last "compartment", there is nothing here of true morphological compartmentation. There is a pair of small thin-walled latero-ventral anterior caeca at the anterior end of the crop but these contain no blood, and large blood-filled completely separate postcaeca; but no other caecation.

The crop curves ventrally posteriorly, so that the posterior end is low in the body-cavity and the intestine is ventral on the floor of the paramedian chamber, horizontal, then arches dorsally with an ascending limb and a descending limb which connects to the rectum. The anterior diverticulate portion includes the ventral horizontal portion and the ascending limb. The four pairs of large dorsally directed tubular diverticula are nearly equal in diameter to the posterior nondiverticulate portion of the intestine, follow a tortuous path, intertwine, extend to the dorsal aspect of the body-cavity, are long and fully occupy the paramedian chamber.

Four pairs of testes are present in the usual position, but nothing further could be determined of the male system excepting a narrow elongate muscular organ crossing obliquely over the dorsal surface of the terminal mass of the male system. The ovaries are elongate, cylindrical, of the form and size in *Bogabdella* but extending further anteriorly before tapering into the tubular oviducts which are bridged beneath, but not above the crop, by a commissure of the diameter of the oviduct. Short paired oviducts descend from this bridge to join into a short small vagina beneath the nerve cord. There was no expansion on the lower portion of the oviducts.

The regional anatomy of the alimentary canal conforms generally to the account by MacCallum and MacCallum (1918), but I saw nothing to correspond to the second, posterior pair of branched tubular glands entering the crop. In the section shown in their Pl. xxxv, it would seem that these "glands" are actually a pair of thin-walled anterior caeca. The ovaries and oviducts seen in the present specimen agree with the description by Oka (1904) and not that by the MacCallums who describe very short oviducts joining to a longer common oviduct.

The present specimen is most valuable in showing the expansion of the whole length of the anterior intestine into a storage organ, a crop extending for its full length from the proboscis to the posterior intestine, and the absence of morphological compartmentation. The proboscis could not be drawn back through the encirclement of the anterior ganglionic mass by tension on the pharynx.

Ozobranchus margoi (Apathy 1890)
(Fig. 1 C)

One specimen taken from *Chelonia mydas* at Heron Island early in 1968 by Dr. H. R. Bustard. Deposited in the Australian Museum, Sydney, N.S.W., Coll. No. W. 4185.

This is the first record of this rare species in the southern hemisphere, as also of its occurrence on *Chelonia mydas*. Otherwise it has been known (Sanjeeva Raj, 1959) in the original collection of thousands of specimens from the head of a single turtle, *Thalassochelys corticata,* in the Mediterranean; two specimens obtained by Oka from *Delphinus longirostris* in the Sea of Sagami, Japan and two further specimens from *Caretta olivacea* on the coast of Fukoka; and finally by Sanjeeva Raj in 1959 who took over a thousand specimens from the right fore-limb of *Eretmochelys imbricata* in the Bay of Bengal near Madras.

Apathy's account is unavailable. Oka's descriptions are meagre. Selensky (1915) gives an internal anatomy of specimens taken by Apathy but essentially no external detail. Sanjeeva Raj (1959) briefly records the taking of the leech. The external features are inadequately known and the species poorly defined other than in the presence of five pairs of filamentous gills.

Unfortunately, my specimen is unsuitable for a detailed study of the internal anatomy. Sufficient was seen to establish that the figures given by Selensky (Pl.i, Fig. 2, general morphology; Pl.vi, Fig. 16, reproductive system) are highly diagrammatic to the point of being misleading and cannot be interpreted correctly from the detail in the text. For example, in Pl.i, Selensky shows a somewhat compartmented crop, wide throughout its length and nowhere narrowed as necessary for this organ to pass through the bridged and limited passage between the oviducts as shown in Pl.vi where the passage is no larger than the second one which is only of such size as to pass the nerve cord.

The single specimen is contracted; the total length, 12·5 mm.; the neck region, 2·0 mm. long, about 0·5 mm. wide anteriorly where it is transversely elliptical, increasing in width posteriorly to become subcircular and about 2·0 mm. in each dimension at the end. The abdomen is broadly ovate in outline; the dorsum longitudinally convex; the venter nearly flat; and uniformly deep over most of the postbranchial region. The abdomen widens rapidly along the branchial somites to a width of nearly 6·0 mm. which is maintained back to xxii/xxiii where it narrows gradually posteriorly to end obtusely and provide a base 2·0 mm. wide to the very large heavy muscular thick posterior sucker which is essentially circular and nearly 8·0 mm. in diameter. Since it is contracted, the sucker must be of very large size in life.

The animal is white, without colour or pattern excepting that the gill-filaments are light brown.

The contracted anterior sucker is deeply cupped. The mouth-pore could not be seen but the point of the needle indicated that it is subterminal. There are no indications of eyes. The neck is strongly contracted and somite

xii almost completely concealed beneath the prepuce. When the prepuce is split along the midventral line, a single genital pore is seen and the point of the needle did not indicate a second pore. The branchiate region is about a third of the length of the abdomen. The first four gills arise each from an anteroposteriorly compressed base which is about as long as the secondary divisions to which the filaments are attached. The first gills are large, about equal to or slightly larger than the second; the third smaller than the second; the fourth much smaller than the third; and the fifth pair much reduced in size and with only some 6 or 7 filaments. The anus is concealed and followed by two annuli complete on all aspects. The posterior sucker is slightly cupped, the rim, thin, and the inner surface, plain. Somital sense organs and nephropores could not be detected.

The contracted cupped form of the anterior sucker prevents recognition of somites i to vi; vii, the first obvious somite, is 2–annulate with $a_1\ a_2 > a_3$ above as also viii to x, and as x and xi are recognizably 2–annulate below, the general nature of vii to x is almost certainly 2–annulate above and below; xi, 2–annulate with $a_1\ a_2 = a_3$; xii, apparently undivided, with a single genital pore median in the somite; xiii to xvii, 2–annulate above with $a_1\ a_2 > a_3$, and the gills extend from $a_1\ a_2$ in each, the furrow $a_1\ a_2/a_3$ is indicated in the marginal region below but not present in the median region of the venter. From my experience with the new leech, it would seem that the branchiate somites are 2–annulate above and below.

In the strongly contracted condition, with no obvious land-marks for the determination of the somital annulation in the postbranchial region, there were indications on one side or other, occasionally across the dorsum of furrows which were deeper than the ordinary interannulars and apparently intersomital. The interannulars were less definite to almost obscure, even erratic on the median third of the dorsum, and all furrowing on the venter was vague and unreliable. Using the "intersomitals" gave the following annulation: xviii (3); xix (2); xx, xxi (3); xxii, xxiii, xiv (4), a pattern so improbable as to be rejected.

The alternative is a 3–annulate condition for xviii to xxvi, which agrees with the uniformity of annulation in *O. branchiatus*, in *O. shipleyi*, and in the new leech. This places the anus at xxvi/xxvii, with xxvii postanal, 2–annulate, and complete on all aspects, dorsal, lateral and ventral. I can see no indication that this is not the correct annulation in the postbranchial region.

So far as seen, the internal anatomy is ozobranchid: the anterior ganglionic mass commences at vi/vii; the ventral nerve cord arches high over the terminal mass of the male system, but the ganglionation of the nerve cord could not be determined. The proboscis is short, anterior to the encirclement of nerve tissue; the long muscular pharynx extends back in xii/xiii with a pair of right and of left glands entering well before the posterior end, each gland a cord of large cells. The anterior intestine was disintegrated excepting for the large postcaeca extending separately back to the paramedian chamber of the body-cavity. The posterior intestine has an anterior ventrally situated short diverticulate portion carrying four pairs of very long tubular dorsally directed diverticula, and a longer acaecate portion with a loop having an ascending and a descending limb, all excepting the descending limb within the median chamber of the body-cavity. The paramedian longitudinal palisades of the dorsoventral musculature are well formed on either side of the posterior intestine and meet posteriorly as a tranverse sheet and the posterior portion of the intestine passes through a foramen high in this sheet, descending behind it to the rectum.

The female reproductive system was grossly swollen, soft, and disintegrated on manipulation. Nothing could be determined from it. Four pairs of testes were present, the last at xvii/xviii. Anterior to the first testis, there was a compactly coiling ensheathed mass of epididymis dorsal to an ensheathed compact, closely coiling narrow muscular duct, which would seem to be the long ejaculatory duct described by Selensky. This is dorsal to an elongate transparent, thin-walled colourless sac containing clear bodies which are of similar size and appear to be mature sperm-balls. The ventral element seems to be the spermatic vesicle of Oka and Selensky, but is much larger in size than in their figures. The above three structures are paired and posterior to the terminal mass of the male system. A thin-walled median, non-muscular elongate ovoid organ attached to the posterodorsal aspect of the terminal mass of the male system, contains white, immature sperm-balls and would seem to correspond to the duct of the seminal receptacles of Oka and Selensky, but the latter could not be recognized.

Bogabdella, gen. nov.

Ozobranchidae; ozobranchiform; anterior abdominal somites carrying each one pair of elongate bluntly terminating digitiform gills; common genital aperture in the middle of xii; large seminal vesicles; ejaculatory ducts, short; seminal receptacles as expansions of the oviducts; no median copulatory duct; anus in the posterior margin of xxvii.

Freshwater. Ectoparasitic on Chelonia. Australian Region.

Type species: *Bogabdella diversa* n. sp. (As below). Type deposited in the Australian Museum, Sydney, N.S.W. Coll. No. W. 4184, taken by Mr. Peter Meyer from *Emydura macquari* at Lake Boga, near Swan Hill, Victoria, Nov. 26, 1967.

(Boga, geogr. name; bdellos, a leech. f.)

Bogabdella diversa, n. sp.

(Fig. 2 E, F, G, H, I; Fig. 3 K, L)

A small leech with the body divided into a distinct anterior sucker wider than the neck; a single pair of eyes; mouth subterminal; short sturdy neck covered briefly by a prepuce; the enlarged abdomen carrying 8 pairs of digitiform gills on the anterior region, and the postbranchial region terminating in a large thick strongly muscular sucker wider than the abdomen. The epidermis is without papillae and generally transparent in life. Colour, dependent on internal structures of which the large paired dark simple independent postcaeca are obvious. Lacking cutaneous pigment excepting for 10 elongate radiating white patches on the dorsum of the posterior sucker.

Preserved, 4·0 to 5·0 mm. long contracted and 7·5 mm. in full extension. The smallest specimen, 2·0 mm. extended. In an extended preserved animal of a total length of 7·25 mm., the anterior sucker and neck total 3·0 mm. in length; the sucker is 1·0 mm. in width. The neck gradually widens to a maximum of 1·5 mm. at the posterior end where the depth is the same. The abdominal region is 4·0 mm. long; the branchiate portion, 2·6 mm. long; the greatest width, 2·3 mm. in the vicinity of the last gill which is also the region of greatest depth, 2·0 mm. The posterior sucker is circular, 3·0 mm. in diameter and nearly 1·0 mm. in thickness. The proportions of the body vary greatly with contraction. In a strongly contracted specimen, the total length is 4·0 mm.; the anterior sucker and neck total 1·0 mm.; the branchiate region, 1·25 mm.; the maximum width, 2·3 mm.; and the posterior sucker is 4·0 mm. in diameter.

The anterior sucker is excentrically attached, the face oblique and broadly oval, the dorsal length about twice that of the ventral. It is shallow, thick-rimmed, and the preocular region forms a distinct short rounded velum. White sensory patches are present on the margin of the velum and of the sucker. The small pore-like mouth is median, located just below the edge of the velum, and subterminal. The single pair of brown eyes are spaced well apart, deeply situated and do not show a distinct outline. The narrow neck forms the base of the sucker. The neck is transversely oval in section anteriorly, deepening and widening to subcircular posteriorly, and in

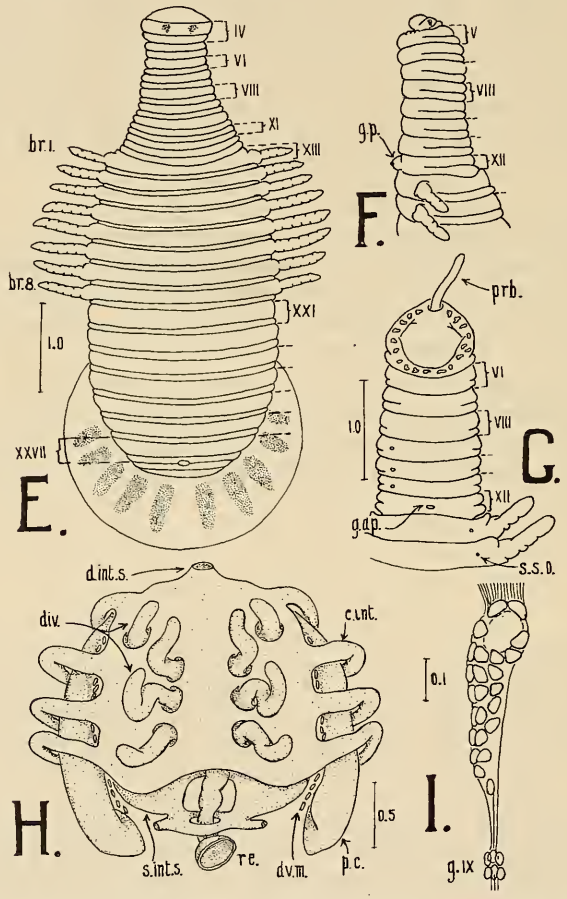


Fig. 2. *Bogabdella diversa*: E. dorsal view; F. lateral, and G. ventral views of the anterior region; H. posterior coelomic system; I. anterior ganglionic mass, left lateral aspect. See key to lettering on figures, p. 80.

contraction the prepuce fully covers xi and xii. The abdomen is longitudinally and transversely convex above, flattened below, and increasingly convex above posteriorly, deepening so that the posterior third of the abdomen in the fully extended animal is almost circular in section. The whole abdominal region is more depressed in the fully extended animal and also in the strongly contracted animal in which it terminates obtusely.

The anterior portion of the abdomen carries 8 pairs of simple, undivided, bluntly terminating, slightly tapering digitiform gills which are transversely ridged or unevenly corrugated in life, translucent, slightly swollen at the

base, and appear to be divided internally by a longitudinal vertical septum. They increase in length from the first to the fourth or fifth, then progressively shorten, but the last gill is always obviously, even if only slightly, longer than the first. In life, the longest gill when extended is more than half the width of the abdomen. The swollen base is not pulsatile. The anus is situated at the base of a distinct pit. The mouth of the pit is always widely open and remote from the base of the sucker. The base of the sucker is about one-third of its width. The sucker is centrally attached but oblique to the long axis of the body due to the fore-shortening of the venter of the body in the postbranchial region.

The body-wall varies in thickness. In dorsal view, the narrow proboscis can be seen between the mouth and the anterior ganglionic mass; many clitellar gland cells; and the large postcaeca. The ventral aspect of the neck is quite transparent, to such degree that the proboscis, anterior ganglionic mass, several independent ganglia of the ventral nerve cord, the muscular pharynx, the mass of the terminal organs of the reproductive system, the seminal vesicles posterolateral to this mass, the diverging rows of the testes, and the postcaeca can all be readily distinguished. These internal structures are visible according to the regional development of the muscular layers of the body-wall, the distribution of the pigmented botyroidal tissue, and the clitellar glands. These large gland cells are situated between the level of the anterior end of the anterior ganglionic mass and the anterior end of the postcaeca as a thick sheet internal to the botyroidal tissue, dorsal and lateral to the internal organs, and in greatest numbers in the genital and pregenital regions. The cells are arranged on longitudinal cords, there being numerous ducts but there are no aggregations of ducts into columns as known in some piscicolids (e.g. *Branchellion*, Meyer, 1941; *Bdellamaris*, Richardson, 1953). The botyroidal tissue is present as a sheet lining the dorsal and lateral aspects of the muscular envelope, thinnest dorsally in the pregenital and genital regions, and increasingly thicker posteriorly to the base of the sucker, but very thin on the ventral aspect of the postbranchial region.

Annulation.—(Fig. 2 E, F, G.) Somital sense organs are minute, rarely visible, never showing as a complete series, and to be seen only on partially extended live specimens where a few supramarginals and submarginals may show as very small white points which are central in the length of a_1a_2 on the neck and abdomen. The nephropores could not be detected. In contraction, fine superficial longitudinal furrowing may subdivide the annuli into narrowly rectangular areas; but such vanish as the animal extends. The intersomital and interannular furrows are definite in the live animal at all times, but are obliterated in the fully extended preserved specimen. They do not show on the venter of the postbranchial portion of the abdomen other than at the margins in the partially contracted preserved specimen.

The dorsum of the anterior sucker is crossed by a furrow which is incomplete laterally, just anterior to the eyes, and an incomplete furrow behind the eyes marking off the ocular annulus which is followed by a shorter annulus, defining iv which is clearly 2-annulate, with $a_1 > a_2 > a_3$, the eyes in a_1a_2, and iv is incomplete, there being no indication of a_1a_2/a_3 on the margin of the velum or on the face of the sucker. The region anterior to iv is a well-defined velum which can be turned ventrally over the upper portion of the face of the sucker. Somite v is narrower than iv, forms the base of the sucker, and iv/v extends onto the lateral aspect so that v then forms the lateral and ventral portions of the margin of the sucker. Somite v is 2-annulate with $a_1 > a_2 > a_3$, and uniannulate below. The intersomital furrows on

the neck are more pronounced than the interannular and the annulation of vi to x is clearly 2–annulate above with $a_1\ a_2 > a_3$, and uniannulate below. Somite x widens and with xi and xii forms the genital region, apparently the clitellum, and although xi and xii are 2–annulate above, the annuli are short, and in these two somites $a_1\ a_2 = a_3$ above. The single external genital pore is commonly mounted on a low, rounded, ventrally directed papilla on xii which shows no annular furrows below, but the papilla may be retracted, the external genital pore in the middle of xii, and covered by the prepuce.

Somite xiii is widened and longer than the anterior somites, divided into $a_1\ a_2 > a_3$ above, uniannulate below; the furrow $a_1\ a_2/a_3$ terminates behind the base of the gill so that $a_1\ a_2$ carries the gill, forms the prepuce above, and strongly sets off the abdomen from the neck. Somites xiv to xx are all 2–annulate above with $a_1\ a_2 > a_3$, uniannulate below, and each carrying a pair of gills on $a_1\ a_2$. Somites xxi to xxvii are postbranchial, 2–annulate above with $a_1\ a_2 > a_3$, uniannulate below, and the somite shorter on the ventral aspect than on the dorsal. The shortening of the somites on the venter is associated with the strong longitudinal convexity of the dorsum of the postbranchiate region.

An anal pit is situated at the posterior border of xxvii. There are two annuli of equal length behind the anus and these are complete on all aspects, dorsal, lateral and ventral, as also xxvii, and these are obviously a provision for an increased flexibility of the body on the sucker made necessary by the great size and thickness of the large and heavy muscular sucker. There is no indication of annulation on the dorsum of the posterior sucker, and the ventral face is plain.

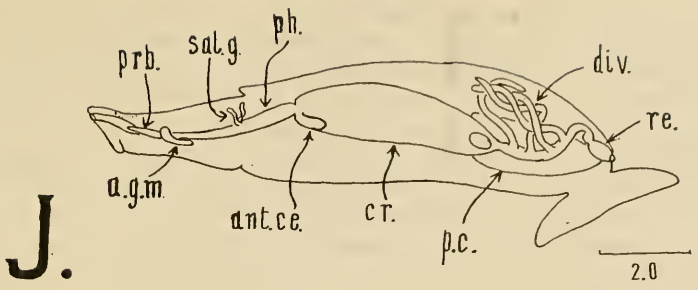
Internal anatomy.—Dorsoventral musculature. (Figs. 2 H; 3 L.)

Dissection showed this system obvious only as strongly developed almost continuous sheet-like paramedian palisades standing between the intestine and the postcaeca, from about xx to xxv or xxvi, so that the postbranchial region contains a very well-formed tall median longitudinal chamber containing the diverticulate and posterior portions of the intestine, and the diverticula; and lateral chambers containing the postcaeca. In the branchial region of the abdomen, the testes and seminal vesicles were rather freely movable in the absence of a paramedian palisade as such, and only some few dorsoventral strands of muscle were present, there being nothing in the nature of a palisade. I could find no indication of formed longitudinal intermediate palisades.

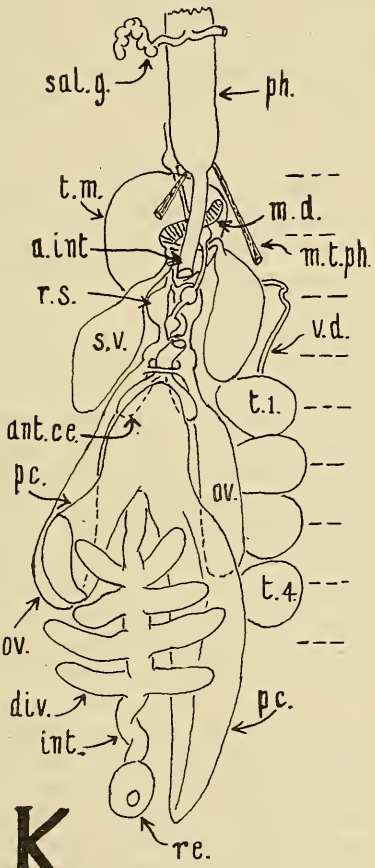
In view of the mass of the posterior sucker, it seems quite possible that the well-developed paramedian palisade may have some function in relation to the sucker. There is certainly no paramedian palisade of this order in the hirudinids where the posterior sucker is moderate to small in size (Richardson, 1969).

Central nervous system.—(Figs. 2 I; 3 L.) There are only 19 independent ganglia on the ventral nerve cord, differing from the usual pattern in leeches of : 21 such ganglia; an anterior ganglionic mass containing 6 somital ganglia; and a posterior mass of 7 somital ganglia. The external somital organization conforms to the usual circumstance of 27 preanal somites.

The first two independent ganglia are pregenital and ventral. The cord then arches high over the terminal mass of the male system, the third ganglion being anterodorsal to the mass; the fourth median dorsal; the fifth posterodorsal; and the sixth posterior and nearly ventral. The sixth and seventh ganglia are slightly crowded, the interspace being no more than the length of a ganglion. The seventh to nineteenth ganglia are ventral, at first well-



J.



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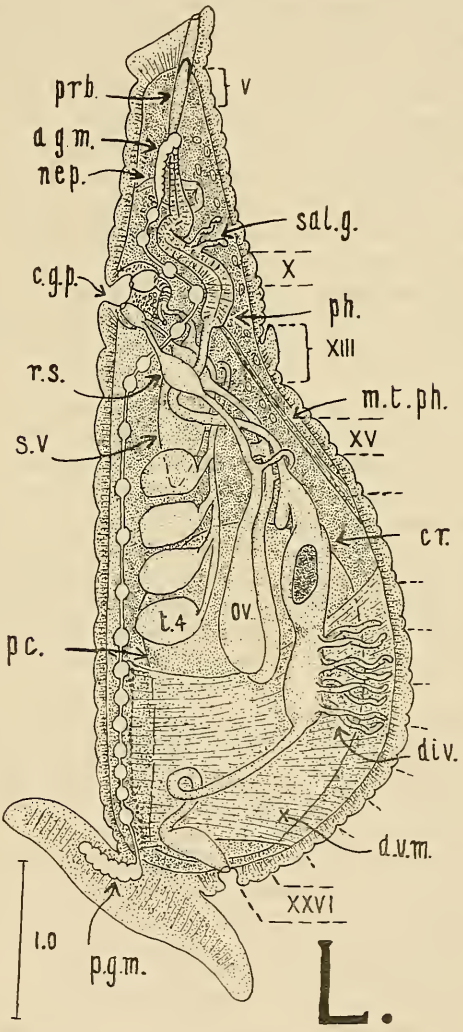

L.

Fig. 3. J. *Ozobranchus branchiatus*, alimentary tract, semi-diagrammatic, only the left intestinal diverticula are included. K. *Bogabdella diversa*, dorsal view of alimentary and reproductive systems dissected and removed, the ovaries and posterior testes displaced laterally. L. *B. diversa*, semidiagrammatic, general internal anatomy from the left aspect. (Note: For clarity, the dimension and form of various organs have been slightly altered and this figure should be read with reference to K, but the postcaeca are shown here as when fully expanded.) See key to lettering on figures, p. 80.

spaced, then closer approximated, the interspace diminishing to about one half of the length of a ganglion, illustrating internally the fore-shortening of the ventral aspect of the postbranchial region; but since the reduction of the interspaces is progressive, there is no indication of an anal ganglion.

Assuming the last independent ganglion to be that of xxvii as usual, the fifth ganglion posterodorsal to the mass of the male system will be the somital ganglion of xiii; the fourth, dorsal to it and above the genital pore, will be xii; and the first independent ganglion will be that of ix.

A whole mount cleared preparation of the posterior sucker stained with acetic alum-carmine shows seven pairs of radiating ganglia in the posterior ganglionic mass, as typical in leeches. Three preparations in a similar manner of the anterior ganglionic mass dissected out from the animal, show 24 (one, 25) ganglionic capsules on the one side, indicating that the mass consists of 8 somital ganglia (the additional capsule in the one case does not disturb this conclusion, and is an error in reading the preparation). This agrees with Selensky's finding (1915) that the anterior ganglionic mass in *O. margoi* consists of the ganglionic components of 8 somites, with the first independent ganglion being the somital ganglion of ix. It will be seen in the figure presented here that the mass is markedly longer in form than in the case where the ganglionic mass contains only the usual 6 somital ganglia.

Alimentary tract.—(Fig. 3 K, L.) This consists of a short proboscis anterior to the anterior ganglionic mass; a longer muscular pharynx; an anterior intestine initially narrowly tubular giving off posteriorly two small ventrolateral caeca, then expanding into a short crop with paired separate postcaeca; a posterior intestine divided into an anterior diverticulate portion and a simple tubular posterior portion; a short rectum.

The protruded proboscis is narrowly cylindrical, weakly muscular, and about 0·5 mm. long. It is housed in a thin-walled sheath extending back to the anterior end of the anterior ganglionic mass in which there is a restricted passage through which the proboscis connects to the much wider strongly muscular pharynx. This latter has also been referred to by authors as "proboscis"; but in dissection it is clear that the passage through the ganglionic mass is of such small diameter that little if any of this muscular organ can pass through it so that it is preferable to distinguish it as a separate organ. No protractor muscles could be found on the pharynx. The pharynx extends from vii to xii/xiii and is ensheathed throughout its length. It is provided with two short tortuous tubular glands, each a cord carrying a few large white gland cells. These enter the dorsal aspect of the pharynx at about the middle of its length. The lumen in both the proboscis and pharynx is minute.

Two long narrow diverging bands of muscle extend from the posterior end of the pharynx back to originate on the dorsal aspect of the body-wall envelope on either side of the mid-line at about xvi/xvii. These would seem to correspond to the retractor muscles described in some piscicolids (e.g. the pontobdellids, Llewellyn, 1966; etc.); but in view of the improbability of protrusion of this pharynx in the ozobranch, the muscles would appear to serve another function. The pharynx is not shortened in the strongly contracted animal, but thrown into a transverse fold in ix and x. The pregenital region is the most extensible portion of the body. In full extension, the posterior end of the pharynx remains in xii. It seems then that the function of these muscles is not the retraction of an anteriorly extended organ, but the retention of the posterior end of the pharynx in position during extension of the pregenital region, this to prevent the transmission

of traction onto the anterior intestine such as would interfere with the function of the crop and postcaeca. The open loop on the first part of the anterior intestine probably has the same functional value. On this interpretation, it is more correct to term these the mm. teniens pharyngis.

The anterior intestine commences at the end of the pharynx as a thin-walled narrowly tubular organ extending posteriorly, dipping ventrally behind the terminal mass of the reproductive system, then ascending between the oviducts to pass between the two transverse bridges joining the oviducts and to give off two short simple thin-walled ventrolateral caeca before expanding into a thick-walled chamber in xvii or xviii and xix which gives off the large thick-walled postcaeca. There is nothing in the tubular region which is suggestive of a crop of the usual nature, no indication of compartments or of other potential for storage. The thin wall of this region is almost transparent and without rugae, as also the ventrolateral caeca in full contrast to the thick wall of the major chamber which is of the same nature as the wall of the postcaeca. The latter extend lateral to the paramedian palisades back into xxv when empty and into xxvii when full. The postcaeca are deep, the dorsal margin curving ventrally, the lower margin almost straight, both conforming to the shape of the abdomen. The lateral face is convex; the medial face partially concave providing space for the intestinal diverticula, ovaries and the posterior testes which lie medial to the postcaeca in the median longitudinal chamber. When partially empty, the postcaeca are light brown above, of the colour of the botyroidal tissue; but brightly bluish green below, a colour of high intensity such as I have not seen in these organs in other leeches.

The posterior intestine is thick-walled, stoutly tubular initially as an anterior diverticulate portion dorsal in xx to xxiii, and shorter than the more narrowly tubular very thin-walled posterior portion. There are four pairs of dorsally directed diverticula originating from the dorsolateral aspect of the anterior region on this intestine. They are thick-walled, narrowly tubular, elongate, corrugated and much folded, intertwining above the intestine; but short, stoutly tubular and brownish in colour when contracted. The posterior portion of the intestine descends ventrally behind the diverticulate region, is thrown into an open loop before connecting to the ventral end of the thin-walled rectum which is short, almost vertical and in xxvii. The anal pit is of the depth of the body-wall.

Reproductive system.—(Fig. 3 K, L.) There is a row of four subspherical testes on each side; the rows diverging posteriorly; the last two pairs of testes being medial to the anterior portion of the postcaeca. As determined by external annulation, the posterior testes are at xix/xx; the anterior, at xvi/xvii. The seminal vesicles are more elongate than the testes and extend from xvi/xvii anteriorly to xiii where they are lateral to the oviducts and the terminal mass of the male system. The vasa efferentia and vasa deferentia could not be seen in simple dissection, but from the manner in which the testes could be moved, it seems that the efferentia open from the dorsal aspect of the testes. In a dissection stained with acetic alum-carmine, a portion of the vas deferens could be seen anterior to the first testis, extending forward into xiv and reflecting posteriorly from there as though to enter the medial face of the seminal vesicle just before the posterior end. The seminal vesicles taper anteriorly each into a short ejaculatory duct, in part applied to the face of the terminal mass of the male system, and then the two enter separately into the end of an elongate muscular organ which is entirely bound to the face of the terminal mass, passes obliquely dorsolaterally over the anterior portion of the mass to enter it on the right side. This

thick-walled muscular duct ends distally in a swollen papilla in the male bursa which opens at the male genital pore in the common genital chamber. This organ has been referred to as a "penis" (Selensky, 1915) but it is bound so firmly to the face of the terminal-mass that it seems most unlikely it is protrusible. I was entirely unable to demonstrate a bulbous or spherical male atrium receiving the paired ducts as described in *O. margoi* by Selensky.

The ovaries vary greatly in size. Non-gravid, the two short ovaries lie side by side lengthwise in the median longitudinal chamber of the body-cavity, beneath the alimentary canal, the posterior end in xix or beneath the diverticulate portion of the posterior intestine. They are posteriorly bluntly rounded, elongate pyriform with a thin transparent wall. All dissected in this condition showed a single large ovum at the posterior end of the ovary, and the ovarian cord simply reflexed anterior to the ovum. The gravid ovaries are enlarged in diameter and lengthened, extending to the posterior end of the diverticulate region on the intestine and uniformly tubular to the level of the first testis so that they extend from xxiv to xvi and occupy the greater length of the abdomen, being morphologically longer than as known to me in the piscicolids. They then each contain in the order of 10 or 12 large dense ova, and the cord is not obvious. The ovaries narrow anteriorly into oviducts which are tubular, widen slightly where they are connected by a bridge transversely above the anterior intestine immediately anterior to the expansion into a crop, and wider again below this to provide the ventral bridge which is more of the appearance of a small compartment connecting the oviducts. Below this, they narrow again as independent ducts expanding each into a distinct vertical chamber just dorsal to the nerve cord, continuing independently below the chambers as narrow oviducts which join separately into the median vagina which is closely applied to the posterior face of the terminal mass. The mouth of the vagina opens into the common genital chamber.

I was unable to demonstrate anything in the nature of a median copulatory duct or paired seminal receptacles and their associated ducts separate from the oviducts as described in *O. branchiatus* (Oka, 1904) and *O. margoi* (Selensky, 1915) and it would seem that the expanded chambers on the lower portion of the oviducts are seminal receptacles.

Coelomic system.—(Fig. 2 H.) On initially opening the abdomen, in several specimens the contents of the coelomic system were seen to be gelled and to present a delicate but definite cast of the coelomic chambers and circumintestinal connections.

A narrow tubular sinus dorsal to the crop expands into a wide flat chamber above the posterior end of the crop and posterior intestine. There are two longitudinal rows, each of four perforations through which the intestinal diverticula pass to become loosely tortuous in the space above the chamber. The chamber is extended laterally on each side by four tubular loops which pass through the paramedian palisade into the paramedian chamber, the first anterior to the root of the postcaecum and so encircling the posterior end of the crop, the other three descending lateral to the postcaecum. These join to the subintestinal sinus which is also flattened, but not as wide as the dorsal and bifurcates posteriorly, the two ends being connected by a dorsal and a ventral transverse commissural sinus so forming a loop around the posterior portion of the intestine. From this loop, short right and left small tubular sinuses extend laterally and then ventrally, possibly to the ventral median longitudinal sinus but this could not be demonstrated.

General observations.—The four original specimens sent me by Mr. John Goode were dead and partially decomposed when received. Mr. Goode then arranged with Mr. Peter Meyer for further material, and Mr. Meyer sent me 8 specimens. He noted that 6 were clustered on the neck of *Emydura macquari* and were very difficult to remove. When they came into my hands some 48 hours later, they were in excellent condition, clear, translucent, quietly active, and the postcaeca expanded with blood. They survived well in water in a petrie dish. I killed the last specimen, still active, 10 days later.

This leech is essentially sedentary. It performs the usual undulatory movement which is commonly referred to as respiratory, but in a rather leisurely manner; the amplitude of the wave is low, and the length is long. The gills move in a metachronial manner as the wave passes along the body; but not at other times, and the gills are generally inactive although capable of an occasional movement. One gill might contract slightly; another, extend; but there is nothing in the nature of a rhythmical movement of the gills in the quiet animal. The gills are insensitive, show no response to stroking with the needle or to other simple stimuli, as is also the case with *Branchellion parkeri.*

Movement of a colourless fluid in the gills can be detected in the motion of small non-pigmented cells. During movement of the body, this fluid was seen to surge in the gill as though on the two sides of a longitudinal vertical septum extending the full length of the gill; but at rest no regular movement of the fluid could be determined. There seemed to be nothing of the nature of the capillary network found in *O. margoi* by Selensky (1915). There was never any indication of pulsation in the swollen basal portion of the gill, nor could pulsatile vesicles be detected adjacent to the base of the gill. Although the transparency of the body was favourable, no contractions of lateral longitudinal vessels were seen.

Sedentary, with the body raised slightly and obliquely on the posterior sucker, the animal has the swollen semiglobular abdomen, short neck, and large posterior sucker which collectively is typically "ozobranchid". The body lowered to the surface can be elongated, the elongation being mainly of the branchial and anterior portions of the body, these regions becoming narrowed and depressed; the anterior sucker bluntly and narrowly triangular; but the postbranchial region remains convex and swollen. MacDonald's figure (1877) is an excellent representation of the extended ozobranch.

The animal moves when gently encouraged to do so, and then there is little of the usual graceful and precise looping which is general among leeches. This is an animal in which the bulk and diameter of the large posterior sucker interferes significantly with movement. With the body extended parallel to the surface, the anterior sucker gains attachment. The body then contracts, slowly dragging the posterior sucker forward across the surface, and if a loop is formed it is at this last moment when the nearly contracted body is raised as a small loop just sufficient to enable the sucker to be placed flat for attachment. Because of the relatively large diameter of this sucker, only a short step is taken. One specimen was 4·0 mm. long contracted; extended to 7·5 mm.; and the step was not more than 4·0 mm. It is a slow, clumsy, poorly managed movement, differing from the piscicolid *B. parkeri* which can move gracefully, rapidly, and most erratically.

Otherwise also, the animal is embarrassed by the mass of the large sucker. It cannot swim. Dropped into water, it sinks without control. Fallen onto its back, the righting reaction is entirely unusual. It is quite typical of other leeches to secure an attachment with the anterior sucker, and to employ this as a fixed point on which to rotate the body lengthwise from the anterior

to the posterior end to gain normal orientation to the surface. *B. diversa* fallen onto its back in water, does not so far as I saw ever gain attachment with the anterior sucker. It appears to attempt to do so, partially and slowly turning the sucker and neck on the long axis, an action spreading onto the first few somites of the abdominal region and no further. Then, as though the release of a lengthwise torsion-tensioned rod, the anterior end rotates rapidly in the opposite direction and the whole animal jerks over into normal orientation without either sucker having first been in contact with the surface. This final action is extremely rapid and positive. It can be recognized that the necessity for some such action as this comes not only from the great mass and diameter of the sucker, but also from the attachment of such a sucker obliquely to the globular relatively inflexible postbranchial region where the capacity for contraction and extension is minimal.

Bogabdella diversa is sensitive to strong light from above, with which it may move or contract, and responds most unusually to strong light from below. With this, it erects the body on the posterior sucker, then coils the neck ventrally in a flat spiral with the anterior sucker on the inside of the spiral, and this is turned down under the branchial region. It remains with the anterior end coiled in this manner until the light is turned off.

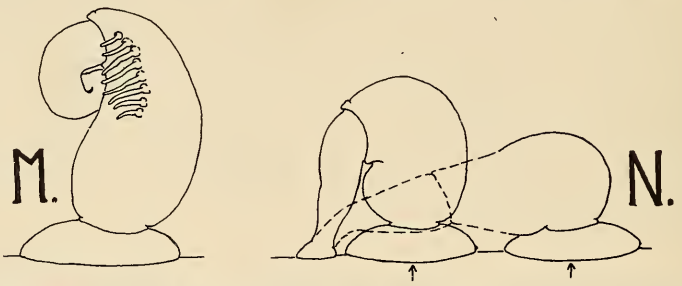

Fig. 4. *Bogabdella diversa*: M. Attitude adopted when subjected to strong light from below. N. Diagram to show the limitation on the length of step due to the large diameter of the posterior sucker and the reduced extensibility of the postbranchial region. See key to lettering on figures, p. 80.

Various authors describe ozobranchs as in a "solid mass", in "clumps", "aggregated" on the host. Five specimens of *B. diversa* were separated widely from one another in a petrie dish at 8.00 p.m. In the morning they were closely aggregated. This was repeated several times. It would appear that aggregation is a natural requirement and clumping on the host something more than the occupation of a limited suitable site. Two placed apart in a petrie dish did not act in the above manner.

The general appreciation of the zoology of the ozobranch is derived from the relatively limited knowledge of *O. branchiatus*. MacCallum and MacCallum (1918) describe and figure the somewhat circular depressed cocoon attached to the turtle; the young leech, unable to swim because of the large sucker; and large colonies indicative of prolonged infestation. The life-history of *Chelonia mydas* would suggest that copulation is the only occasion on which this sedentary leech could transfer from one host to another; but although hermaphrodite, a new infestation would require the transfer of an already inseminated leech, or two others as the minimum. Transfer at copulation would fit to the fact that to date *branchiatus* is known from only *C. mydas*, which is then the entire world of this leech, a rigidly defined host-parasite relationship in which speciation of the leech by isolation would be fully anticipated.

The wider host-list for *O. margoi* undermines this proposition, especially now with *C. mydas* known as a host also for *O. margoi*. *B. diversa* offers a convenient opportunity for the intimate study of the zoology of an ozobranch which combined with the incidence on turtles at Lake Boga could make a most valuable contribution to our understanding of these leeches.

The utilization of the blood-meal is unusually rapid. Only the postcaeca contained blood when the leeches were received here, and the postcaeca are essentially empty of blood after five or six days away from the host at summer temperatures.

The body-wall becomes increasingly transparent in the starving animal. A loss of condition is first shown in the appearance of erosion at the tips of the gills, followed by constrictions across the gills which divide the gill into sections, and then sections break away progressively from the distal end of the gill, to leave finally only the base of the gill to mark its former presence. There is no obvious loss of body-fluid in this amputation by constriction. As the section breaks away there is no rush of fluid in the stump which seems to be tightly sealed off. In one specimen in good condition when received, the last gill on the left side was indicated by only a short rounded lobe. Such might be a consequence from an earlier period of physiological stress.

Acknowledgements

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KEY TO LETTERING ON FIGURES

a.g.m., anterior ganglionic mass; a.int., anterior intestine; ant.ce., anterior caecum; br., gill; c.g.p., common genital pore; c.int., circumintestinal loop; cr., crop; d.int.s., dorsal intestinal sinus; div., intestinal diverticulum; d.v.m., dorsoventral muscle; g., somital ganglion; g.ap., genital aperture; g.p., common genital papilla; int., posterior intestine; m.d., male median muscular duct; m.p., mouth-pore; m.t.ph., m. teniens pharyngis; nep., nephridium; ov., ovary; p.c., postcaecum; p.g.m., posterior ganglionic mass; ph., pharynx; prb., proboscis; re., rectum; r.s., seminal receptacle; sal.g., salivary gland; s.int.s., subintestinal sinus; s.s.o., somital sense organ; s.v., seminal vesicle; t., testis; t.m., terminal mass of male system; v.d., vas deferens. Note: Somites are indicated by Roman numerals. All scales in millimetres.